OBJECTIVE: Design an advanced Multi-aperture Differential Image Motion Analysis (MaDIMA) and monitoring system for marine wave boundary turbulence and atmosphere characterization in submarines.

DESCRIPTION: Design an advance metrological sensor based on multi beam and Multi-aperture Differential Image Motion Analysis (MaDIMA) system for the purpose of atmospheric turbulence by using MaDIMA and analysis and monitoring, marine wave boundary layer temperature, pressure, and atmospheric particle contents. The proposed technology shall be based on high-energy multiband short pulse (pico-second) laser, Light Detection and Ranging (LIDAR) technology in time domain, and focal plane array (FPA) for image and intensity mapping from a back-scattered laser. One of the key aspects of this system is that it is mono-static, meaning both laser and MaDIMA are collocated. The metrological system shall survive in a marine environment including temperatures from -40 °C to 60 °C, thermal shock (hot air at +66 °C to warm water at +20 °C and cold air at -54 °C to cold water at 0 °C), severe icing, and UV sunlight. The ultimate objective under the proposed concept shall incorporate pixel-by-pixel mapping of local optical turbulence parameter (Cn2), temperature, pressure, and evaporation fluctuation from periscope-to-target at far field. The MaDIMA system shall consist of short pulse lasers, known as transmitter and detector Focal plane arrays to detect image pulse, and is the receiver in the metrological system in the topic.

Current technology is based on single aperture differential image motion monitor (DIMM) technology. The disadvantage of the system is it requires distance source and it provides only the average marine turbulence parameter only.

This SBIR topic will increase mission capability, increase performance, and/or reduce lifecycle costs by providing advance awareness of Marine Wave boundary atmosphere by optimizing the sensor software and hardware.

PHASE I: Develop a concept to characterize marine wave boundary atmosphere based on MaDIMA and multiband pico second high-energy laser. Demonstrate the feasibility of the concept of multi-aperture differential image motion monitoring and analysis/characterization. Ensure that the proposed concept is able to measure 3-D temperature, pressure, humidity, evaporation, marine particle size (based on the mie scattering or Rayleigh scattering), etc., using active multiband Pico-second lasers integrated with FPA. Co-locate both the laser transmitter and receiver of the metrological system so any optical path of the scatter signal from the atmosphere or reflected signal from the target shall be detected. Ensure that the system operates in multiple mode, such as LIDAR and particle size. Describe and demonstrate the concepts and design of the proposed architecture of the system. The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype solution in Phase II.

PHASE II: Design and develop single lab prototype MaDIMA systems for testing and evaluation. Use this lab prototype to collect data and calibrate system performance. Use the prototype system to characterize marine wave boundary layer atmospheric parameters to show the technology has the potential to meet the performance as metrological instruments under all modes of operation. In the period of performance for the Phase II Option II, if exercised, the Navy shall provide the 3 band Pico-second Laser as Government Furnished Equipment (GFE) to build the integrated MaDIMA system and deliver the field prototype MaDIMA system to the Navy for further evaluation at a Navy Lab. Develop a Phase III transition plan.

PHASE III DUAL-USE APPLICATIONS: Support the Navy in transitioning the technology for Navy use. Identify the final product and describe how the Navy expects to support transition to Phase III. (Note: The Government will identify the platform or program where the technology has the potential to be used and describe how the technology will meet critical Navy needs.) Assist the Navy with evaluation of the prototype product performance with a standard off-the shelf instrument to calibrate the product; and with validation, testing, qualification, and certification for Navy use as a metrological tool.

REFERENCES:


KEYWORDS: Marine wave boundary layer (MWBL); Focal Plane Array (FPA); Differential image motion monitor (DIMM); Multi aperture differential image motion analysis(MaDIMA); Picosecond LIDAR